




AIR QUALITY IN VIRGINIA

Virginia Department of Environmental Quality



Particle pollution (immediately below) moves east over the North Atlantic Ocean from the East Coast of the United States. *Satellite image courtesy National Aeronautics and Space Administration*

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Air, thankfully, is inescapable. It is the natural resource that touches every aspect of our lives, no matter where we live. Yet for all of its importance, air is invisible. We can't see, taste, smell or touch it. But perhaps that is why it has always captured our interests.

Thousands of years ago, the nature of air was debated in religious and philosophical circles. Hundreds of years ago, scientists began investigating its properties. As cities expanded and more people relied upon the burning of oil, wood and coal to fuel industries, the quality of air grew in importance. Decades later, the invention of the automobile added a new source of pollution and a new awareness.

The ultimate protection of air quality is in the hands of every individual.

In the United States, a national effort to protect air quality began in earnest in 1963 with the passage of the U.S. Clean Air Act. This law made the reduction of air pollution a cornerstone of environmental protection at both the national and state levels. In Virginia, the Department of Environmental Quality works to protect air quality. Air quality protection is a part of the Commonwealth's environmental laws as well as its constitution.

Although government agencies are charged with ensuring good air quality, air pollution does not stop at political boundaries. Local air quality is as affected by our own actions as by people in other states. Since what we do influences what we breathe, the ultimate protection of air quality, and by extension our health and way of life, is in the hands of every individual.

The Constitution of Virginia, Article 11

Further, it shall be the Commonwealth's policy to protect its atmosphere, lands, and waters from pollution, impairment, or destruction, for the benefit, enjoyment, and general welfare of the people of the Commonwealth.

Virginia's air

The Commonwealth has made significant progress in improving air quality in the past several years. For most of Virginia, the number of unhealthy air quality days due to high air pollution levels has decreased, and air pollution controls on industries appear to be working. For example, there was a summertime reduction of 11,000 tons of smog-forming pollution from 2002 to 2005. The amount of ozone (the main ingredient in smog) that is being transported into Virginia also has been reduced significantly. Particle pollution continues to meet the federal health standard throughout the Commonwealth.

Air quality improvements have been the most significant in the areas of Richmond, Hampton Roads, Fredericksburg and Shenandoah National Park. In the past, these areas did not meet federal air quality standards for ozone, meaning that ozone levels were too high. After reviewing three

continuous years of improved air quality measurements, the U.S. Environmental Protection Agency classified these locations as “attainment” areas, meaning they have met the air quality standard for ozone. These areas will continue working to keep ozone levels low.

The Commonwealth has made significant progress improving air quality in the past several years.

A few localities in Northern Virginia do not meet air quality standards for ozone. These localities are considered “nonattainment” areas by EPA. DEQ and its partners are work-

ing to reduce ozone levels in these areas. Although particle pollution levels meet the standards in Northern Virginia, this area is a nonattainment area for particle pollution because it is part of an air quality control region, including Washington, D.C., Virginia and Maryland, that does not meet the federal standard.

DEQ works cooperatively with EPA, Maryland, Washington, D.C., the National Park Service, the Forest Service at the U.S. Department of Agriculture and local agencies in Fairfax County and Alexandria to monitor and protect air quality.

Helping small businesses

Own-
ing a business is full of responsibilities, including understanding and complying with Virginia's environmental requirements. For small businesses, help is available at DEQ. The agency runs a non-regulatory, voluntary program that offers small businesses free and confidential technical assistance. The program helps businesses identify and comply with air quality and related environmental requirements. This assistance includes explaining regulatory requirements, providing permit application assistance and identifying cost-effective compliance options. The program also has loaned more than \$1.9 million from the Commonwealth's Small Business Environmental Compliance Assistance Loan Fund to help small businesses pay for emission control equipment, implement pollution prevention measures or institute agricultural best management practices.

Air pollution

From the air we breathe to the food we eat, air quality affects our lives. Air is a mixture of invisible and odorless gases, mostly nitrogen and some oxygen. Clean air is essential to keeping people, plants and animals healthy.

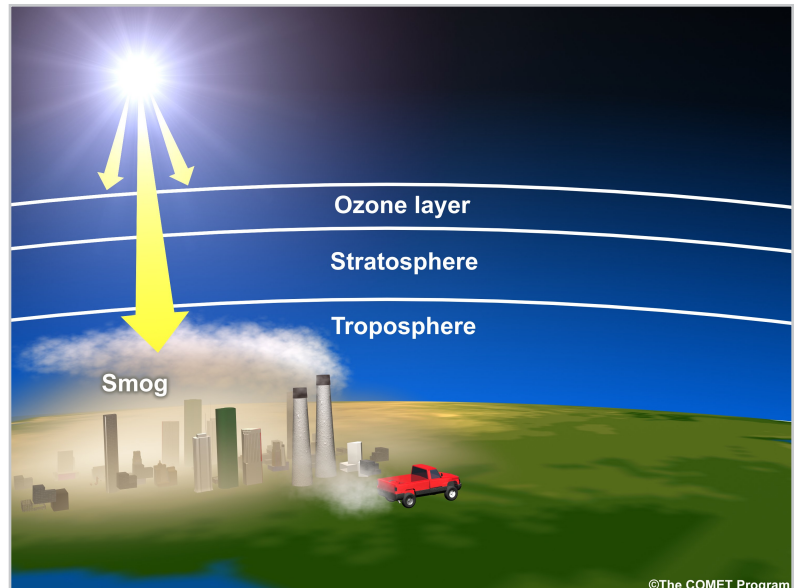
Air pollution is any particle or gas in the air that at high levels negatively affects the environment or human health. Pollution can result from natural conditions, such as volcanic eruptions and forest fires, and human activities, which cause the most concern. High levels of air pollution can cause or aggravate health problems in people and damage the environment.

Motor vehicles and factories are common sources of air pollution. Industrial and commercial pollution sources include petroleum refineries, power plants, steel production, cement manufacturing and metal processing facilities, and diesel-powered locomotives, airplanes and ships. The burning of oil, gas, coal and other fuels like wood releases gases and particles into the atmosphere. Even refueling a vehicle or residential activities such as painting a house can contribute to air pollution.

Common air pollutants include nitrogen oxides, carbon monoxide, sulfur dioxide and organic chemicals. These air pollutants may retain their original form or react with other substances in

Ozone: Good up high, bad nearby

The atmosphere can be divided into different layers. The lower atmosphere or the layer closest to the Earth's surface is called the troposphere. In the lower atmosphere, high levels of ozone can aggravate human health conditions. Ground-level ozone, the main ingredient in smog, is created when sunlight causes the reaction of nitrogen oxides and organic chemicals in the atmosphere. In Virginia, ozone is a concern during the summer months when sunlight and warm temperatures may increase the production of smog. In the next layer, called the stratosphere, ozone protects people from harmful ultraviolet light from the sun. It is produced naturally in the upper atmosphere where it forms the protective "ozone layer."



the atmosphere. For instance, nitrogen oxides and organic chemicals, also called volatile organic compounds, react in the presence of sunlight to form ozone.

Ozone and particle pollution

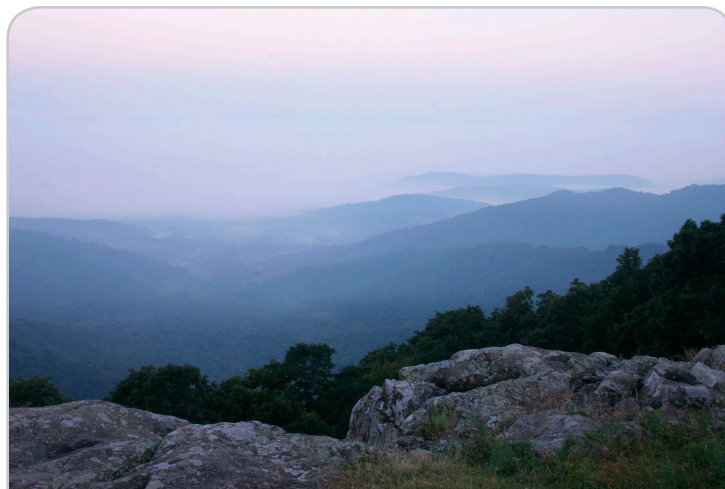
Ground-level ozone is a colorless gas formed by the reaction of sunlight with vehicle emissions, gasoline fumes, solvent vapors, and power plant and industrial emissions. Ozone formation is most likely in hot, dry weather with little or no winds.

Particle pollution is made up of particles found in soot, dust, smoke and fumes. The burning of coal, oil, diesel and other fuels produces these particles. The particles are small enough to enter deep into the lungs and cause health problems.

Ozone and particle pollution have been linked to short-term health concerns, particularly among children, asthmatics, people with heart or lung disease and older adults. The effects of these pollutants can be minimized by avoiding strenuous activity or exercise outside when levels are high. To help people plan their activities, DEQ issues daily air quality forecasts. While Virginia experiences some poor air quality primarily in the summer, the number of days with unhealthy air pollution has declined in recent years.

Haze

Haze can reduce outdoor visibility, making it difficult to see for long distances. Haze is formed when pollution particles in the air either absorb or scatter sunlight, which affects the clarity and color of what people see. The distance that someone can see is influenced by a number of factors, including



Trees in the Blue Ridge Mountains emit gases that react with sunlight and contribute to a blue haze that gives the mountain range its name. *Photo courtesy National Park Service*

the amount of particle pollution and the size of the particles.

Industrial emissions, vehicle exhaust, dust from construction sites and soot from wildfires can contribute to haze. Some state and federal regulations that reduce nitrogen oxides and sulfur dioxides from industrial emissions help decrease haze. Haze can also be produced naturally from trees and plants. Trees in the Blue Ridge Mountains, for example, emit gases that react with sunlight, eventually turning into aerosols, and form a blue haze that gives the mountain range its name.

While everyone would like a clear view, visibility is especially important for parks and other recreational areas. For example, many people visit Shenandoah National Park for its spectacular views. Under some conditions though, the views are hidden by haze. Virginia is working with federal officials to ensure that visibility in the park and the James River Face Wilderness in Bedford



The image shows the comparison of good visibility on the left and poor visibility on the right due to haze. The photos were taken from Dickey Ridge in Shenandoah National Park, looking southwest to the Shenandoah Valley. *Photo courtesy National Park Service*

County returns to natural conditions. DEQ is predicting clearer skies in the future for both areas, which are meeting and exceeding deadlines for improved visibility.

Acid rain

Acid rain is really rain, snow or fog that contains sulfuric or nitric acid that forms from sulfur dioxide and nitrogen oxides. These chemicals usually travel many miles before falling to the ground as acid rain. Acid deposition has been monitored in Virginia since the late 1970s. Currently, there are eight acid deposition monitoring sites in the Commonwealth.

Rainfall is naturally somewhat acidic. The acidity of rain is measured on the pH scale that ranges from 0, which is severely acidic, to 14, which is extremely basic. A pH of 7 is neutral. Overall,

rain in Virginia is less acidic today than it was in the 1990s. In 1994, the acidity of rain in Virginia ranged from 4.3 to 4.5 on the pH scale. In 2005, the pH range was 4.5 to 4.7. For comparison, lemon juice has a pH of 2 and baking soda has a pH of 8. Although the improvement seems small, it is significant since the pH scale is based on a factor of 10. A pH of 5, for example, is ten times less acidic than a pH of 4. Amendments to the Clean Air Act in 1990 and additional emission control rules have contributed to the improvement.

A primary concern of acid rain has been the adverse effects on native trout streams in the Blue Ridge Mountains. Native brook trout are among the most sensitive fish species. These trout streams are in mountainous areas that have thin soils. The soils have a limited ability to safeguard against acid deposition, and rainwater runoff can contribute to increased acidity in the streams.

Mercury in the environment

Mercury is a naturally occurring metal that is released to the environment from some manufacturing and industrial activities. Once mercury is deposited in streams, rivers, lakes or wetlands, natural biological processes can convert it into a toxin called methylmercury. Fish become contaminated with methylmercury when they are exposed to it from water and sediment and eat other organisms that contain the toxin. Eating contaminated fish is the primary way people are exposed to mercury.

In recent years, states from Florida to Maryland and from the Great Lakes to New England have discovered elevated levels of mercury in fish from waters that do not have any sources directly emitting mercury. These findings prompted DEQ to conduct additional monitoring in waters without significant, known sources of mercury pollution in eastern Virginia.

Mercury can be deposited in waterways when it rains or through other natural processes.



DEQ biologists collect fish from the Blackwater River in southeastern Virginia to investigate mercury contamination.

DEQ has found that fish in some rivers, swamps and lakes in eastern Virginia are contaminated with mercury. These waters appear to be mercury-sensitive, meaning they are more likely than other waters to have natural conditions that are favorable for the conversion of mercury into methylmercury.

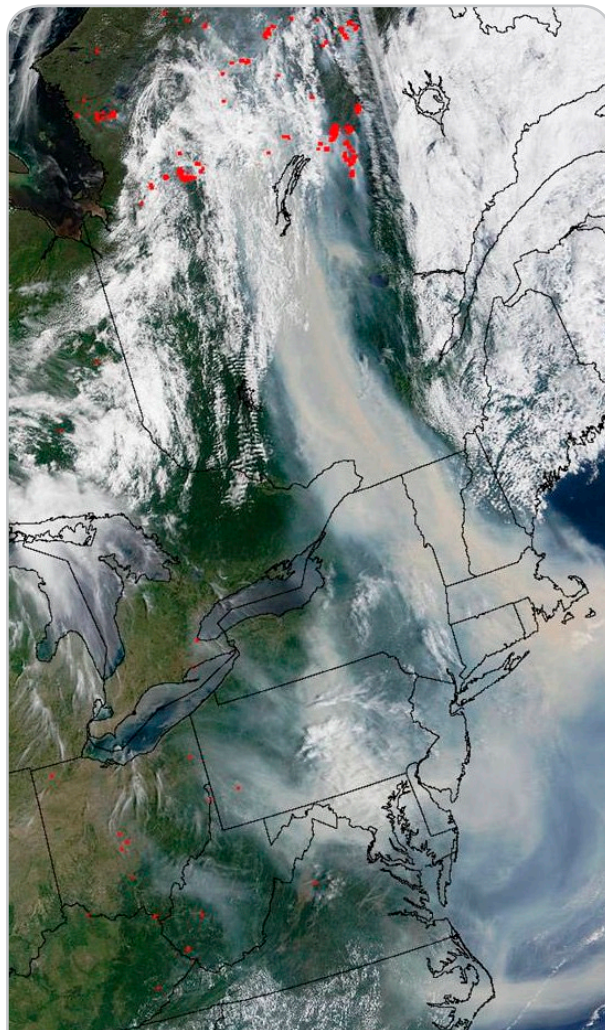
DEQ is investigating possible pollution sources and the reasons why elevated levels of mercury appear in these waters, including the role of mercury in the air. In 2007, the agency began its first detailed assessment on the effects of mercury in air emissions. It includes studies on the risk to human health from eating fish contaminated with mercury and how the metal is deposited from air emissions. From these studies, DEQ plans to evaluate the effectiveness of regulations that limit mercury emissions and how these emissions may affect Virginia's environment, especially its rivers, lakes and estuaries.

Weather and air quality

Air moves in invisible currents around the planet that are influenced globally by the oceans, the Earth's rotation and energy from the sun. On a smaller scale, local weather patterns have an effect on air movement and air quality.

Large areas of high pressure in the atmosphere can settle over the Commonwealth in the summer and lead to more air pollution, especially ground-level ozone. High pressure systems trap pollution near the ground, creating weak winds that prevent the air from mixing. When combined with sunshine, these conditions are ideal for local pollution levels to increase. Winds that are high in altitude can transport pollution from sources hundreds of miles upwind of Virginia, particularly in the Ohio River Valley. The high-altitude pollution may mix down to the surface as sunshine heats the air each morning. This may cause the high-altitude pollution to contribute to locally produced pollution near the surface. Historically, this effect has led to some of Virginia's worst air pollution days. Fortunately, recent pollution control rules have significantly reduced the amount of pollution emitted upwind from and transported into Virginia.

The Bermuda High, another summertime weather feature, leads to south or southwesterly winds, bringing heat and humidity (moisture in the air) over the region. The Bermuda High is an area of high pressure in the atmosphere that forms over the Atlantic Ocean during hurricane season. Sunshine, heat and humidity are prime conditions for particle pollution levels to increase. Occasionally under certain weather conditions, ground-level ozone and particle pollution may reach levels on the same day that are unhealthy for sensitive people.



Canadian forest fires (red dots, top) contributed particle pollution to the air over Virginia and other Mid-Atlantic states in July 2002. An area of high pressure forced the smoke plume, several hundred miles in length, to flow south of the fires. *Satellite image courtesy NASA*

Protecting air quality

The U.S. Congress passed an important federal air pollution control law, known as the Clean Air Act, in 1963 and added additional protections with significant revisions in 1970 and 1990. National air quality standards determine how clean the outdoor air must be, and it is up to each state to see that its air meets these standards. In 1966, the Virginia General Assembly passed a law to control air pollution in the Commonwealth. DEQ works to ensure that both the state and federal requirements are met through issuing permits that limit air pollution, establishing rules or regulations, inspecting facilities, and enforcing laws and regulations.

Many industrial facilities and businesses need permits from DEQ that limit air pollution. A permit is a license or an authorization for a facility to operate in Virginia. It may place restrictions on operations and may require air pollution control technology. Air permits allow for industrial

growth to occur while at the same time protecting human health and the environment. Air pollution sources range in size from large industrial facilities and power plants to small commercial operations.

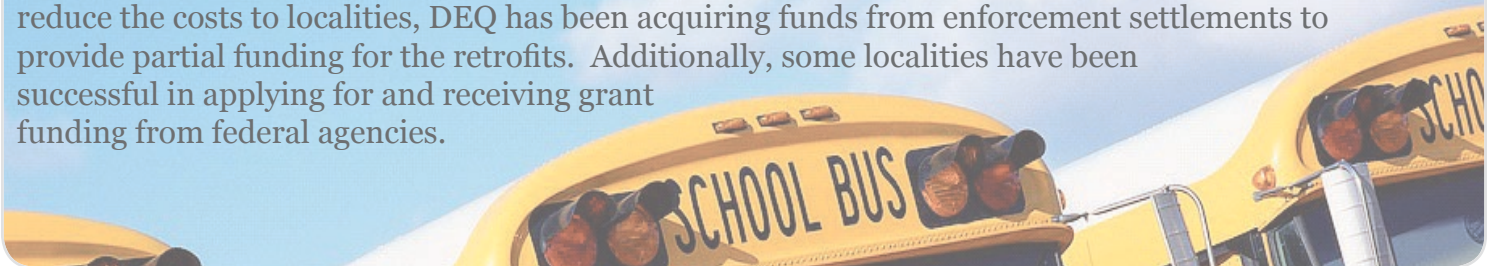
In addition to issuing permits, DEQ is responsible for establishing regulations or rules that protect air quality. These regulations set standards for issuing permits, enable DEQ to implement and enforce plans to meet air quality goals, modify pollution control requirements to reduce emissions, and update air quality programs and regulations to reflect changes in federal requirements.

The plans that are developed by DEQ are required by the federal government to control air pollution and protect air quality. To support the plans, the agency conducts comprehensive estimates, called emissions inventories, of pollutant amounts emitted on a daily basis from factories, businesses, vehicles and other sources.

Pollution controls for school buses

DEQ, several school districts and the American Lung Association are undertaking projects to reduce emissions from diesel-powered school buses. School buses often are used up to 15 years in Virginia, and older diesel engines release more pollution than newer engines. Retrofitting school buses with certified pollution control devices can reduce emissions of certain pollutants by up to 50 percent.

Retrofits can cost from \$1,000 to \$3,000 per bus, depending upon the equipment installed. To help reduce the costs to localities, DEQ has been acquiring funds from enforcement settlements to provide partial funding for the retrofits. Additionally, some localities have been successful in applying for and receiving grant funding from federal agencies.



From the emissions inventories, DEQ determines what type of pollution controls should be implemented to curb pollutants in areas that do not meet air quality standards and uses computer modeling or simulations to test the plan's strategy for reducing emissions. DEQ is involved in other projects that include regional modeling as it relates to particle pollution, ozone and haze, and special projects such as studying the air deposition of mercury and nitrogen in Virginia.

DEQ performs on-site inspections at many facilities. If facilities fail to comply with permit and regulatory requirements, a violation has occurred. Violations also occur when someone conducts illegal activities. Violations are often found during facility inspections by DEQ and through review of reports and data submitted by permit holders.

When an enforcement action appears necessary, DEQ issues a notice of violation that describes the problem and requires the permit holder to enter into discussions to resolve the issue. DEQ enforcement specialists negotiate appropriate actions, including operational or equipment changes, or site cleanups. If formal action is necessary, DEQ issues an order to the facility at the end of the discussion process. An order directs the permit holder to comply with the cleanup plan and schedule, and if appropriate, pay a civil penalty.

Many industrial facilities and businesses need permits from DEQ that limit air pollution.

Virginia also establishes rules or regulations that protect air quality.

DEQ performs inspections to ensure that facilities follow the permit requirements and regulations.



A DEQ inspector reviews equipment at a power plant.

If DEQ suspects an environmental crime has occurred, the agency refers the case to law enforcement for review and potential prosecution. While DEQ does not participate in the decision to prosecute a case, the agency's criminal investigator collects evidence on behalf of criminal prosecution authorities. DEQ's criminal investigator also works closely with three task forces in western, central and Tidewater Virginia as a mechanism for investigating criminal cases.

Monitoring

Monitoring the air we breathe has come a long way since the 1960s when scientists set plastic containers outside to capture pollutants, collected a month at a time and reported in tons per square mile. Today there is a specialized instrument for each pollutant measured, and DEQ obtains some pollutant measurements on a daily basis.

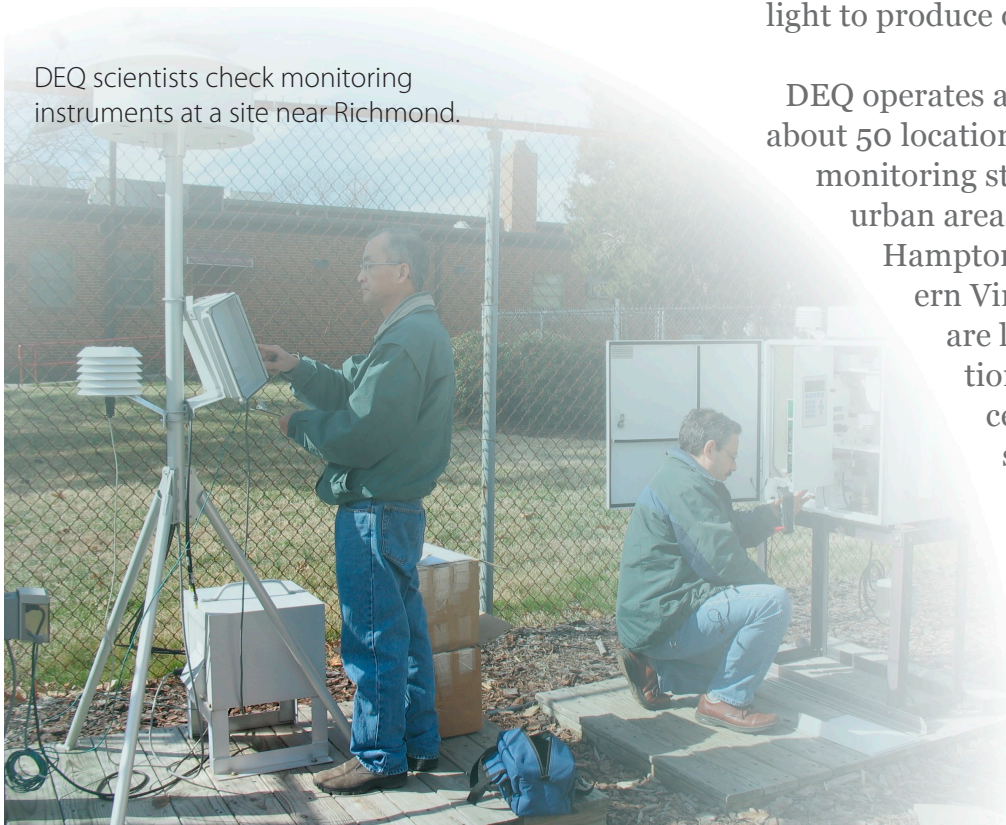
The work done by DEQ's monitoring network forms the foundation of what is known about Virginia's air quality. By monitoring pollutants in the air over time, scientists can determine air quality trends, and identifying how they change can determine if air quality is improving or not.

Some common air pollutants that are found over most of the United States include: ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, particle pollution and lead. In high amounts, these pollutants can harm human health and the environment. They are called "criteria" pollutants because EPA has developed health-based guidelines or criteria as a basis for setting regulations to control how much of each pollutant can safely be released in the air. These guidelines are called the National Ambient Air Quality Standards. DEQ monitors these pollutants through its statewide monitoring network.

DEQ also measures hazardous air pollutants in the Fairfax County, Tidewater and Richmond areas. Hazardous air pollutants measured by DEQ include metals, compounds that react with sunlight to produce ozone and organic chemicals.

DEQ operates air monitoring instruments at about 50 locations around the state. Virginia's monitoring stations are primarily in or near urban areas, such as Richmond, Roanoke, Hampton Roads, Winchester and Northern Virginia. Some monitoring stations are located in rural areas. These stations record background levels of certain air pollutants and help assess the amount of pollution that urban areas contribute to surrounding air. In addition, rural sites can provide information on pollution that is transported long distances and comes into Virginia from outside its borders.

DEQ scientists check monitoring instruments at a site near Richmond.



Reducing vehicle emissions

As part of the metropolitan Washington, D.C., area, 10 localities in Northern Virginia must reduce ozone and particle pollution to meet federal air quality standards. DEQ works to improve air quality by reducing vehicle emissions in Northern Virginia. Vehicle exhaust emissions contribute to particle pollution and ozone production.

Vehicle owners in parts of Northern Virginia are required to have an emissions inspection every two years. Once an inspection has been completed, the Virginia Department of Motor Vehicles downloads the inspection report into its computer system. If the vehicle passes the inspection or is issued a waiver, it is eligible to receive a state registration.

To address excess vehicle emissions caused by problems that occur before the required inspection, the Commonwealth measures pollutants in tailpipe exhaust while a vehicle is being driven on roadways. DEQ is using information from the on-road monitoring to identify polluting vehicles. This monitoring effort ensures that vehicles with high emissions levels will be repaired on a timely basis instead of wait-

ing until the next scheduled inspection. It will also allow a large number of vehicles to be observed without inconveniencing drivers. Emissions information may also be used to reward owners of ex-

ceptionally clean automobiles by allowing up to one additional year of registration without an emissions inspection.

DEQ works to improve air quality by reducing vehicle emissions in Northern Virginia.



At roadside monitoring stations, a pollution sensor is placed on one side of the road and a reflector on the other. The pollution sensor sends invisible light through the exhaust of a vehicle while it is being driven. The changes in the intensity of the transmitted light indicate the concentrations of the exhaust gases. The monitoring equipment checks for excess levels of particles and smog-forming gases such as carbon monoxide, hydrocarbons, and nitric oxides. While measurements are taken of the exhaust, a camera takes a picture of the vehicle's license plate. This information is sent to a computer inside a van at the monitoring station and then transmitted to DEQ.

Air quality today and tomorrow

Of the most common air pollutants, people are most susceptible to the health effects of ground-level ozone and particle pollution. For this reason, Virginia and other states notify the public about current and estimated air quality conditions.

In much the same way meteorologists can predict weather, they can also estimate air quality. DEQ issues daily forecasts of particle pollution for the metropolitan areas of Richmond, Hampton Roads and Roanoke year round. From May to September, the agency also issues daily forecasts of ozone for these cities and Winchester. The forecasts include information on expected levels of ozone and particle pollution, and alert citizens when high pollution levels may occur.

Media representatives around the state receive the forecasts and report the information on television, radio and in newspapers. Local environ-

mental groups also use the forecasts to encourage businesses and industries to reduce emissions when pollution is expected to be at elevated levels. On those days, citizens also are encouraged to take steps that will help keep the air clean.

In Virginia, air pollution levels are reported to the public by a color code and related health advisory as indicated by the Air Quality Index or AQI. The index is a measurement of air quality that is calculated from ozone and fine particle pollution measurements over the past few hours. A higher AQI indicates a higher level of air pollution and a greater potential for health problems. By following the recommendations on outdoor activities in the forecasts, people can reduce their exposure to air pollution. Air quality information is available on the DEQ and EPA websites.

The forecast for Northern Virginia is issued through a collaborative effort with other state and local meteorologists, and monitoring personnel in the greater Washington, D.C., metropolitan area.

Tips for reducing pollution

Every day

- Save power. Turn off lights and appliances.
- Share a ride or use public transportation.
- Avoid excessive engine idling.
- Check your vehicle's tire pressure. Accurate tire pressure will reduce fuel use.

When pollution is elevated

- Refuel vehicles and equipment after dusk and avoid spills.
- Limit or stop the use of gasoline-powered lawn equipment.

Air Quality Index Level of Health Concern	Color	Numerical value	Meaning
Good	Green	0-50	Good air quality. Little or no health risk.
Moderate	Yellow	51-100	Moderate. People who are unusually sensitive to air pollution may be mildly affected.
Unhealthy for sensitive groups	Orange	101-150	Unhealthy for sensitive groups. These groups may experience health problems due to air pollution.
Unhealthy	Red	151-200	Unhealthy. The general public may experience mild health effects. Sensitive groups may have more serious health problems.
Very unhealthy	Purple	201-300	Very unhealthy. Everyone is susceptible to more serious health problems.

The AQI is a measurement calculated from ozone and particle pollution measurements. It is color-coded by level of health concern. Sensitive groups include children, asthmatics, people with heart or lung disease and older adults.

Current conditions and next day forecasts

www.deq.virginia.gov/airquality

www.airnow.gov



Virginia Department of Environmental Quality

P.O. Box 1105

Richmond, VA 23218

(800) 592-5482

www.deq.virginia.gov